

# Current and future EUMETSAT missions in the operational tropical cyclone analysis and forecasting

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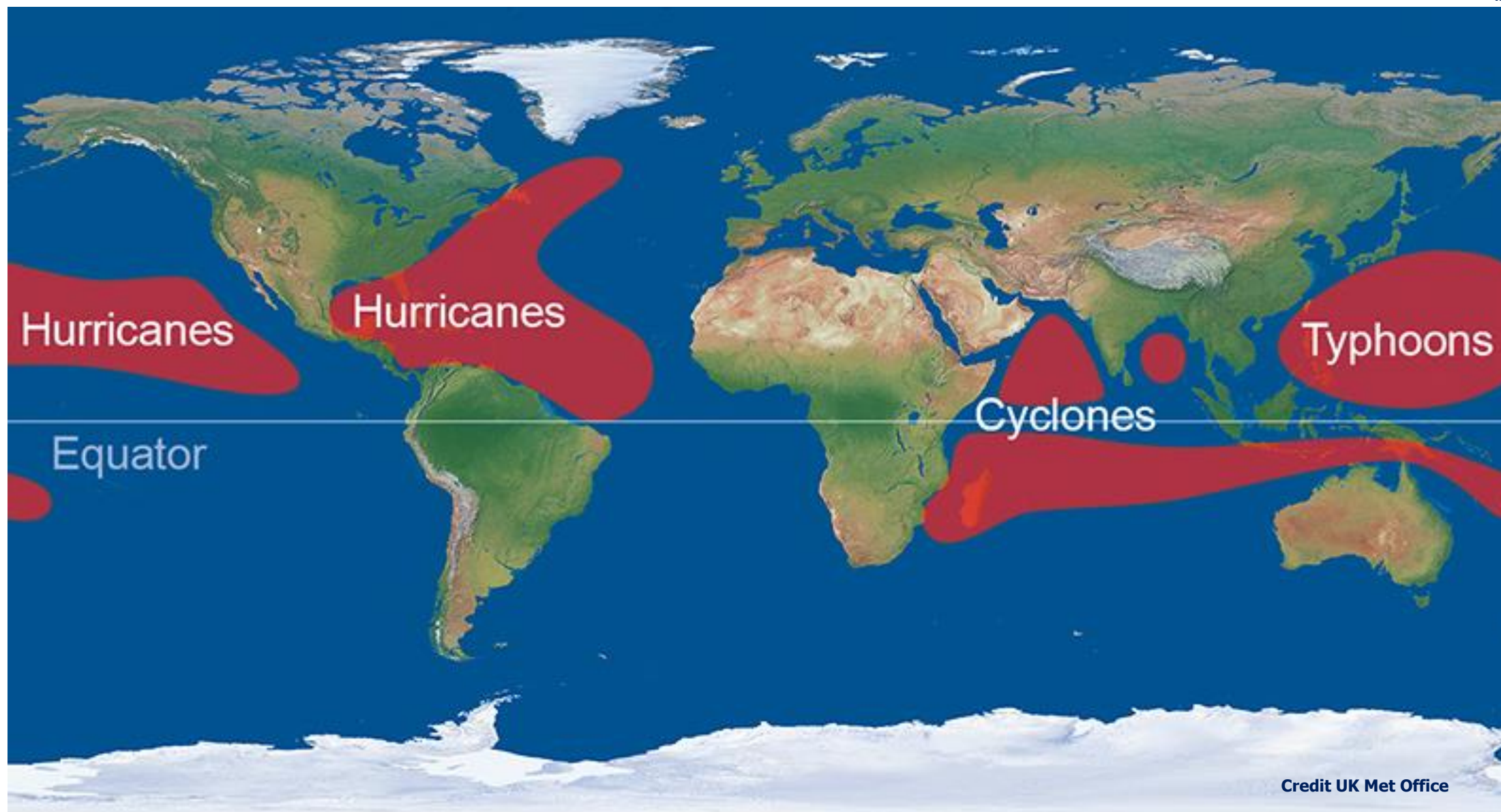


## View from GEO

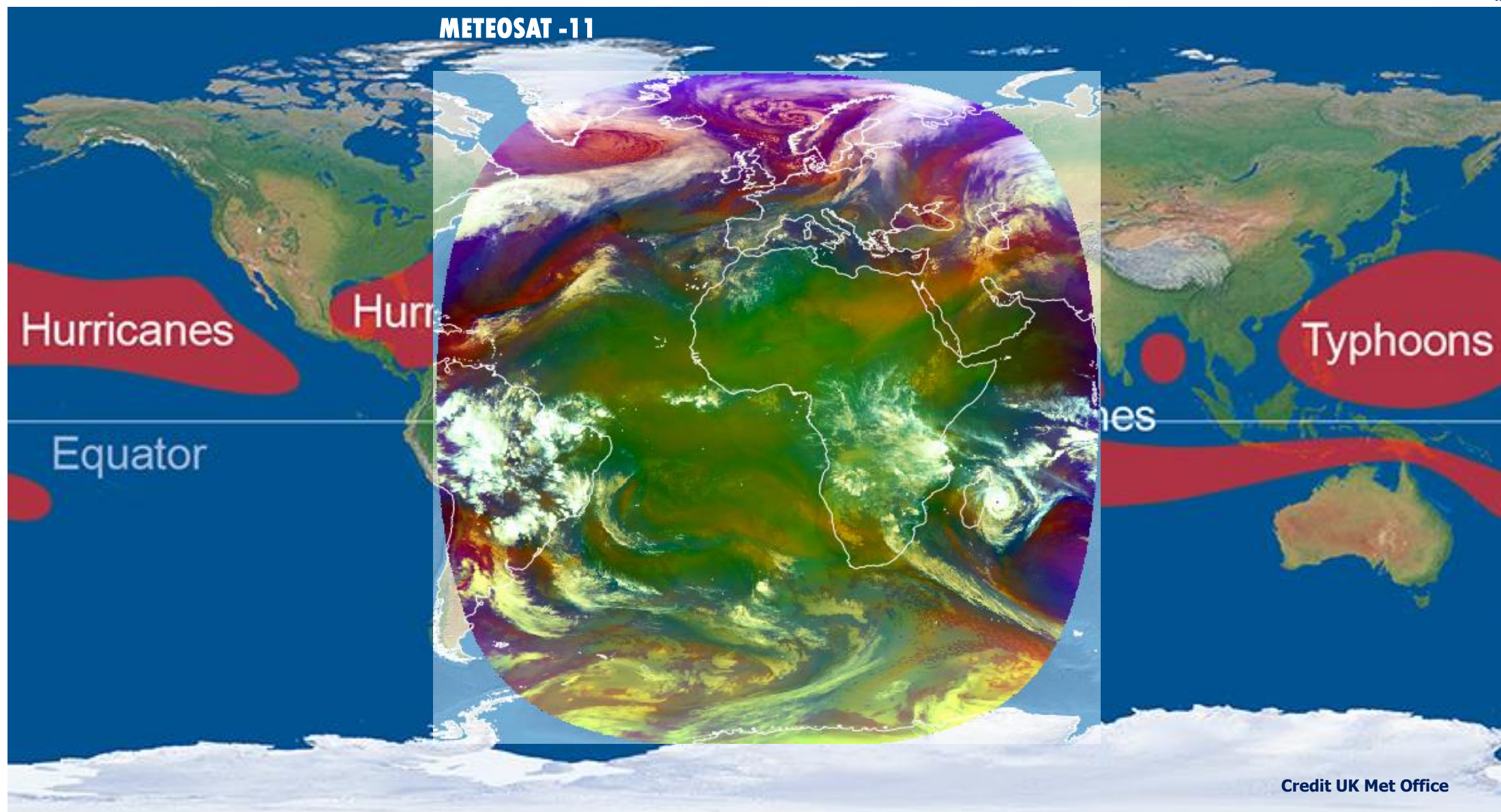
- Tracking the cyclones in Indian and Atlantic Ocean with sensors on **MSG** satellites
- Future focus – **MTG-I** and **MTG-S**: New satellites, new and improved sensors, new possibilities

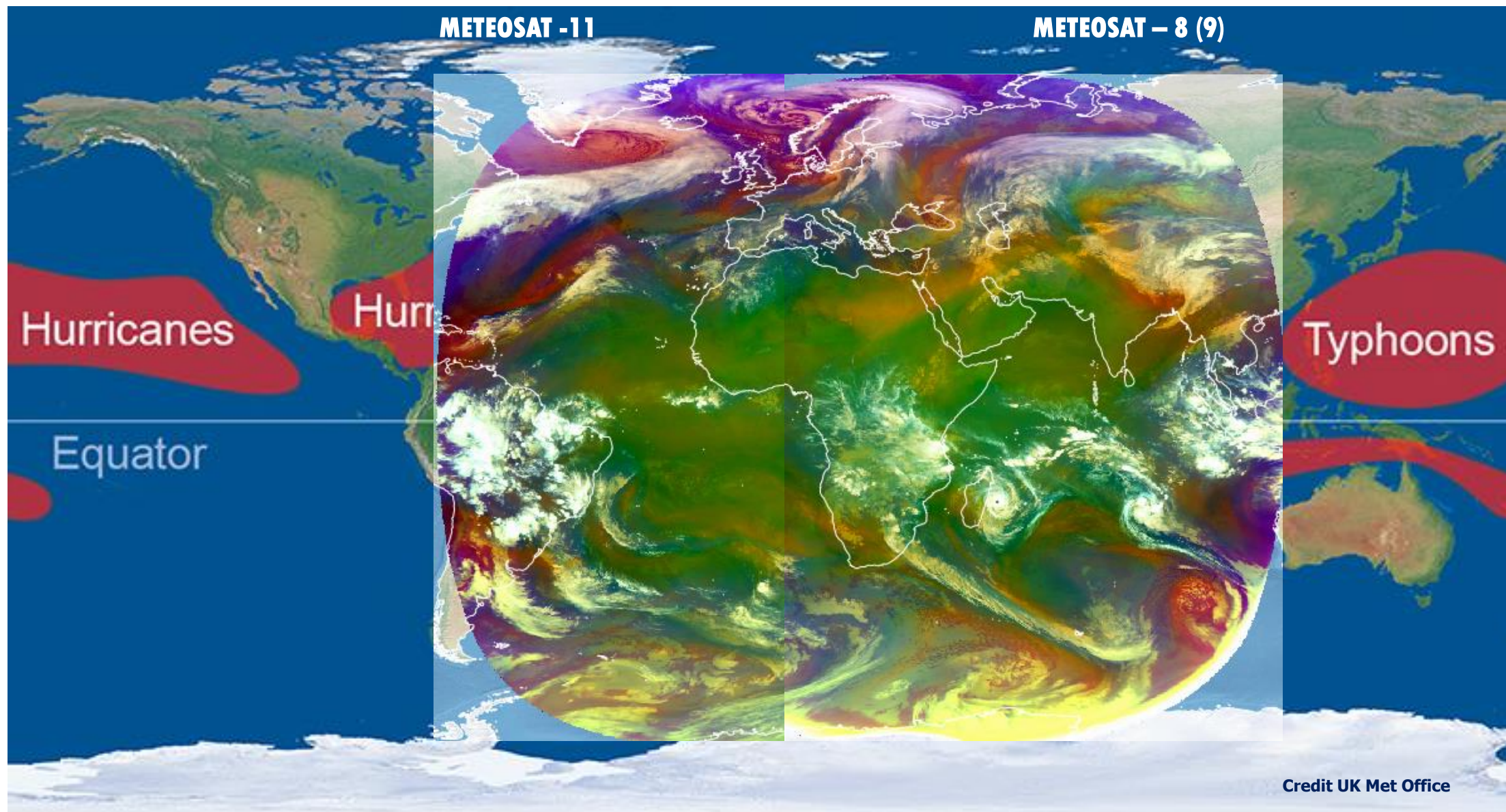
## View from LEO

- Measuring wind speed and SST with sensors on-board **MetOp**
- Look into the future – **EPS-SG**: improvements and benefits



Credit UK Met Office

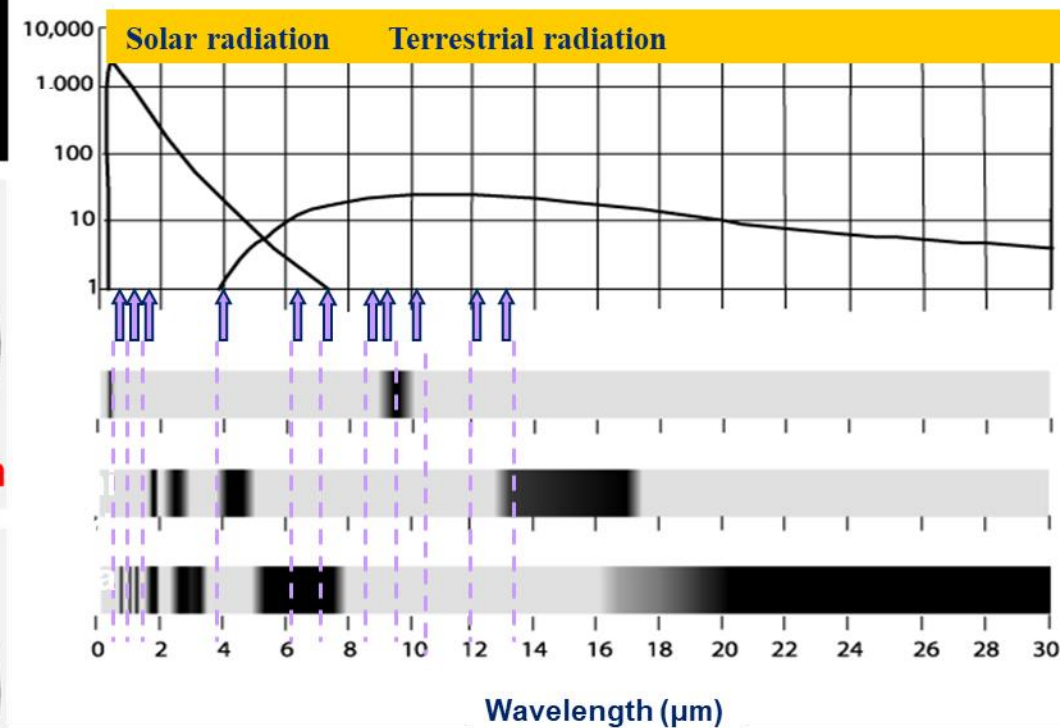
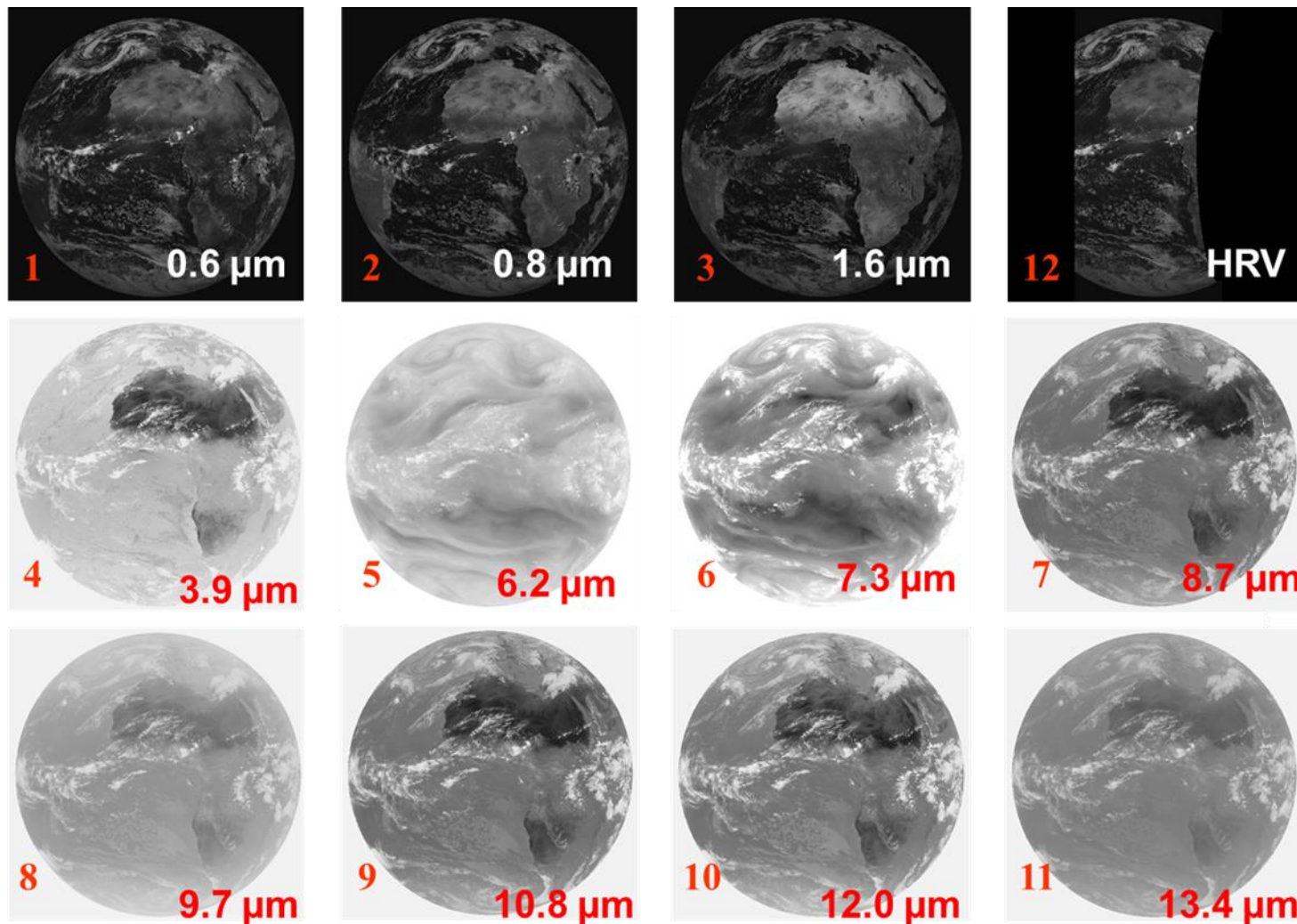






# MSG SEVIRI spectral channels

[www.eumetsat.int](http://www.eumetsat.int)





**MSG SEVIRI**

**IR 10.8**

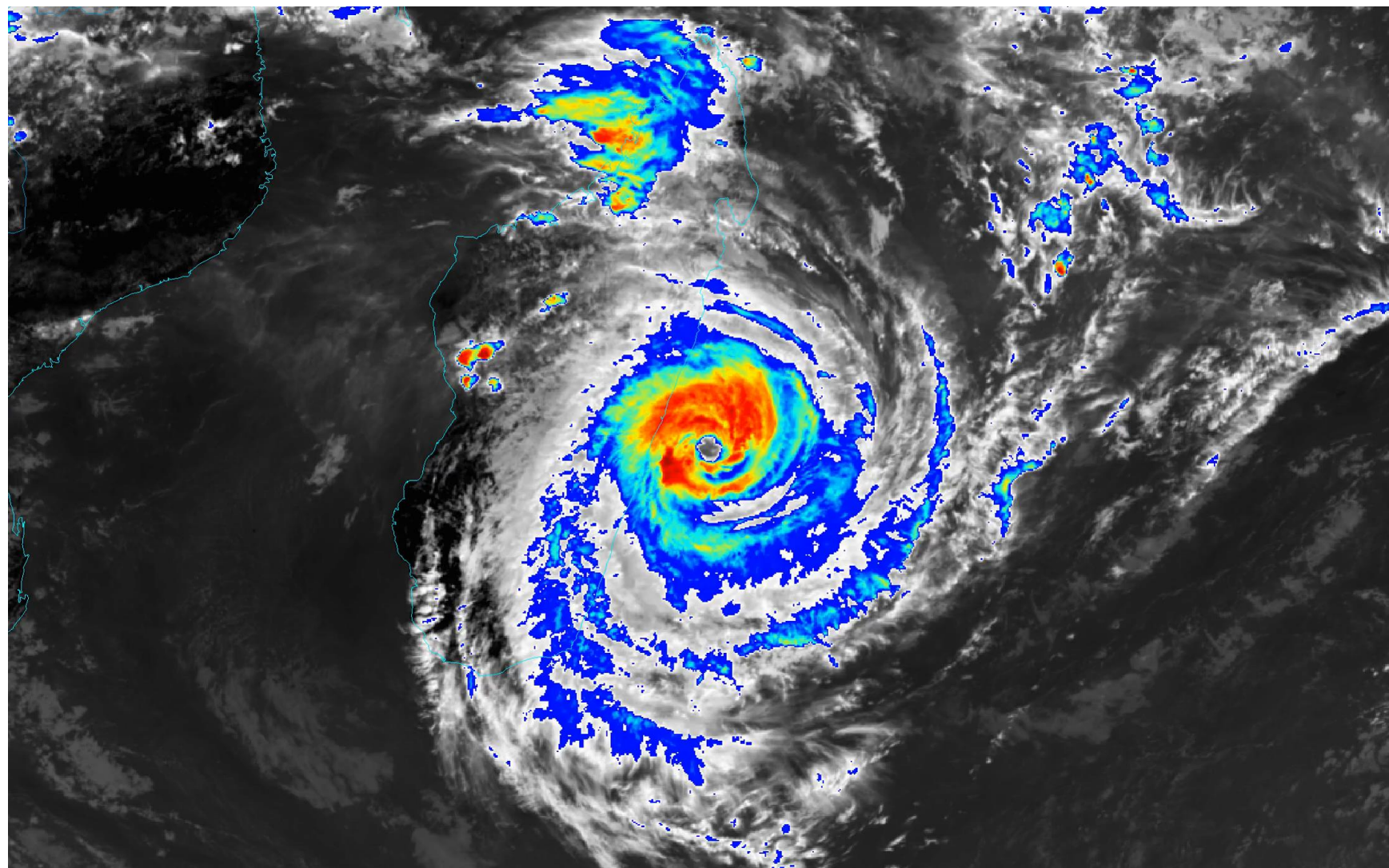
**information on cloud top  
temperature and height**

**Resolution:**

**15 (5) min temporal**

**3 km spatial**

**TC Batsirai – February 2022**



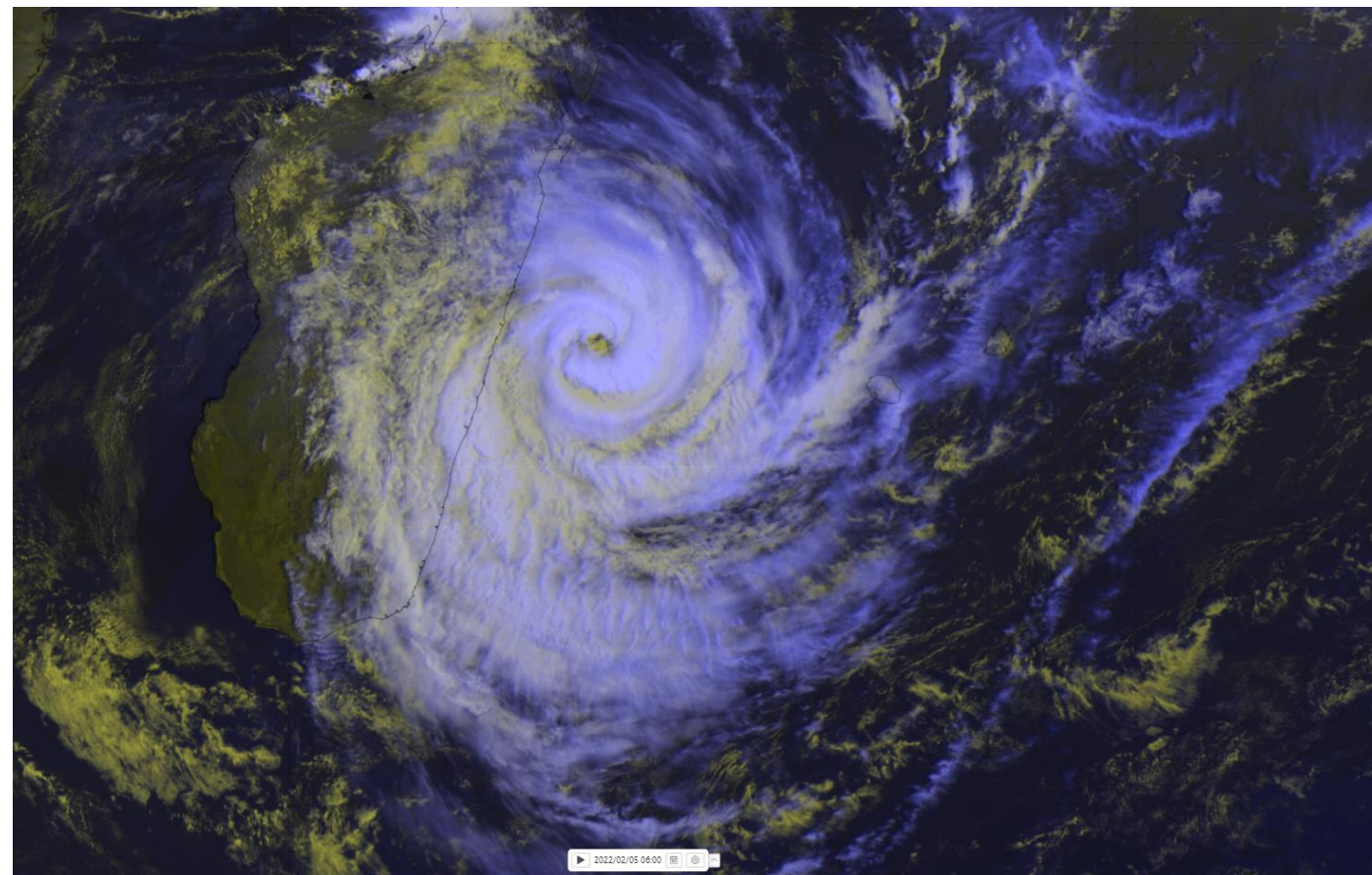
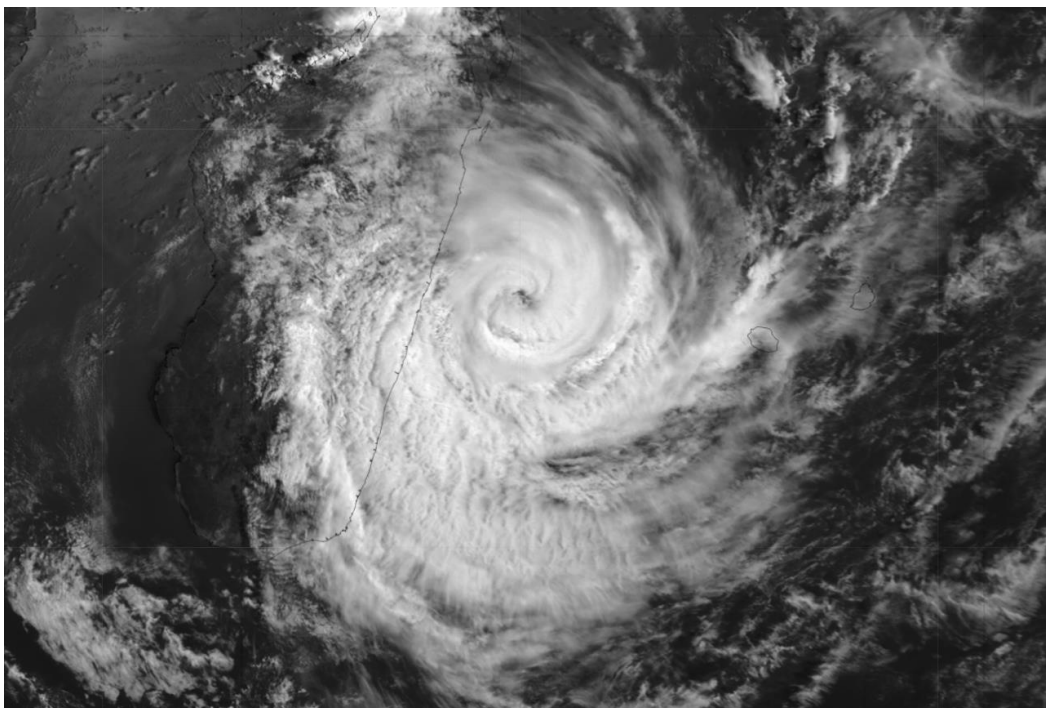
05-02-2022 09:30 UTC



## MSG SEVIRI HRVIS

Showing the fine details in the cloud structures  
in 1km resolution

TC Batsirai – 05 February 2022, 06 UTC



**HRV clouds RGB**

Colour beam	Channel	Range			Gamma
Red	HRV	0	100	%	1
Green	HRV	0	100	%	1
Blue	IR10.8 inverted	323	203	K	1



# Areas of intense development (convection)

www.eumetsat.int

## MSG SEVIRI

### Severe storms RGB

### (Convection RGB)

IR1.6 – particle phase

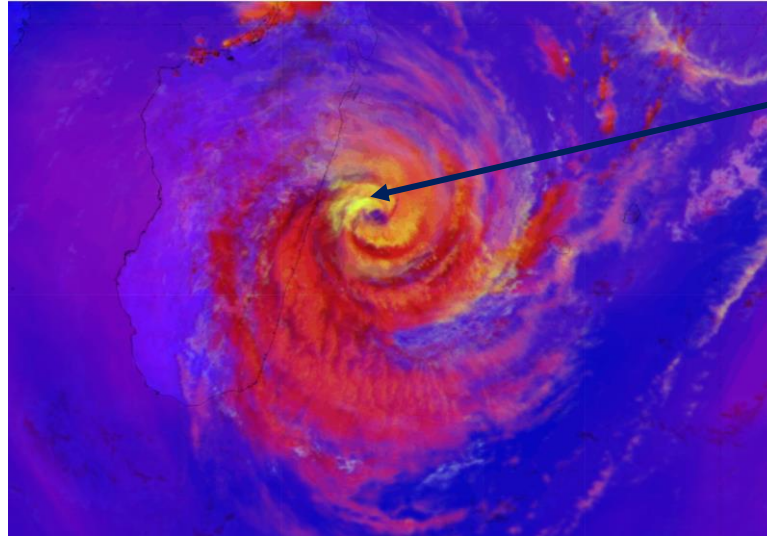
IR3.9 – particle size

IR3.9 - IR10.8

Helps to find areas with most intense development (precipitation)

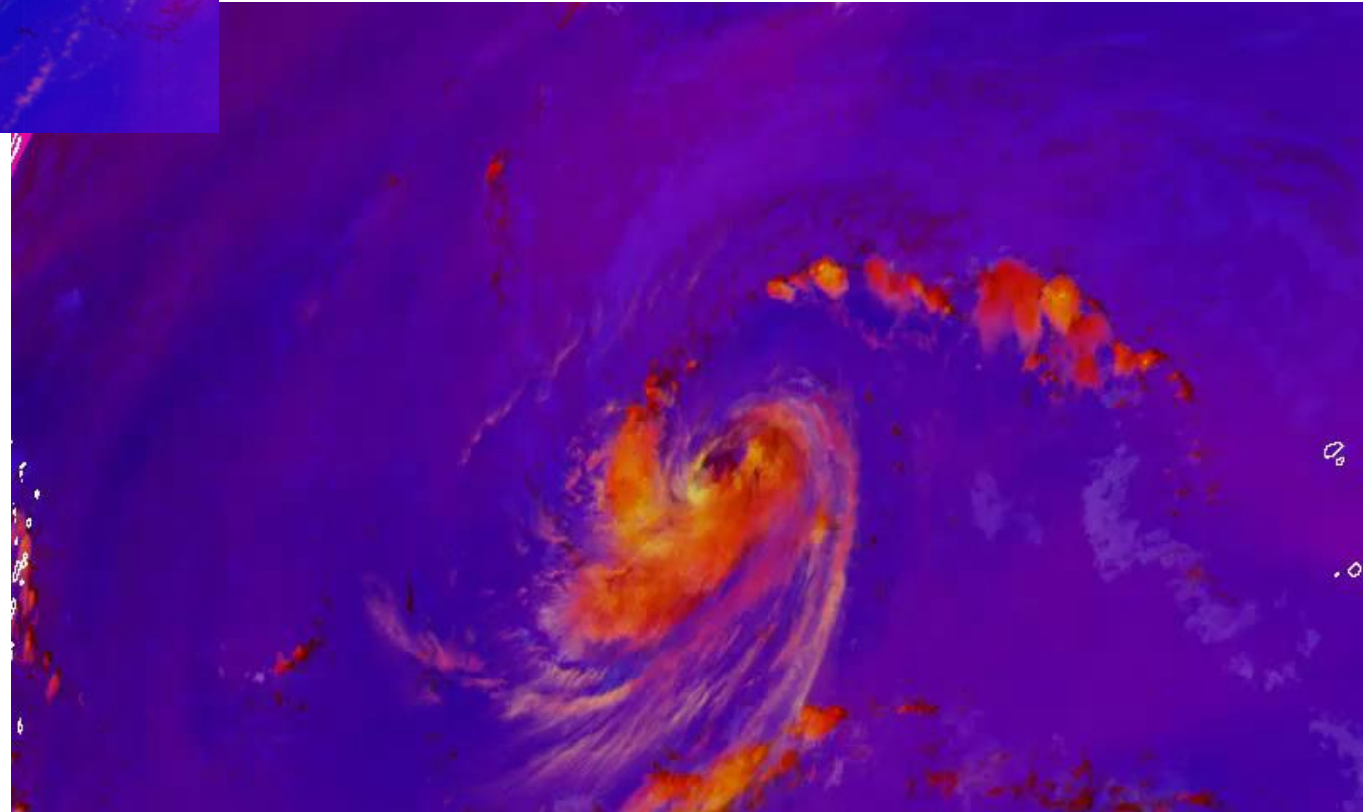
### Severe Storms RGB – tuned for tropics

Colour beam	Channel difference	Range			Gamma
Red	WV6.2 – WV7.3	-35	+5	K	1
Green	IR3.9 – IR10.8	-5	+75	K	0.33
Blue	NIR1.6 – VIS0.6	-75	+25	%	1



Small ice particles = intense precipitation

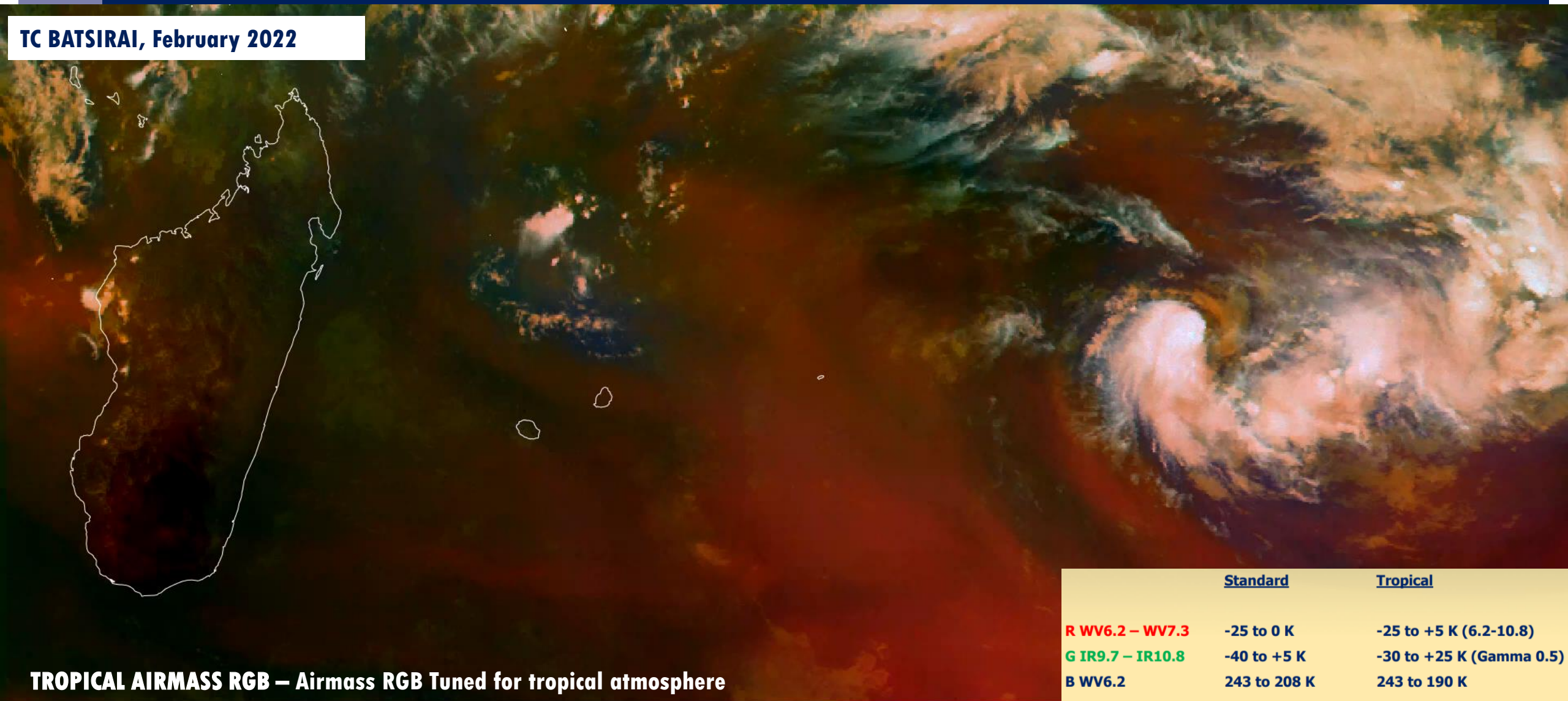
Hurricanes Igor and Julia , September 2010





# Following cyclone development 24 h

TC BATSIRAI, February 2022



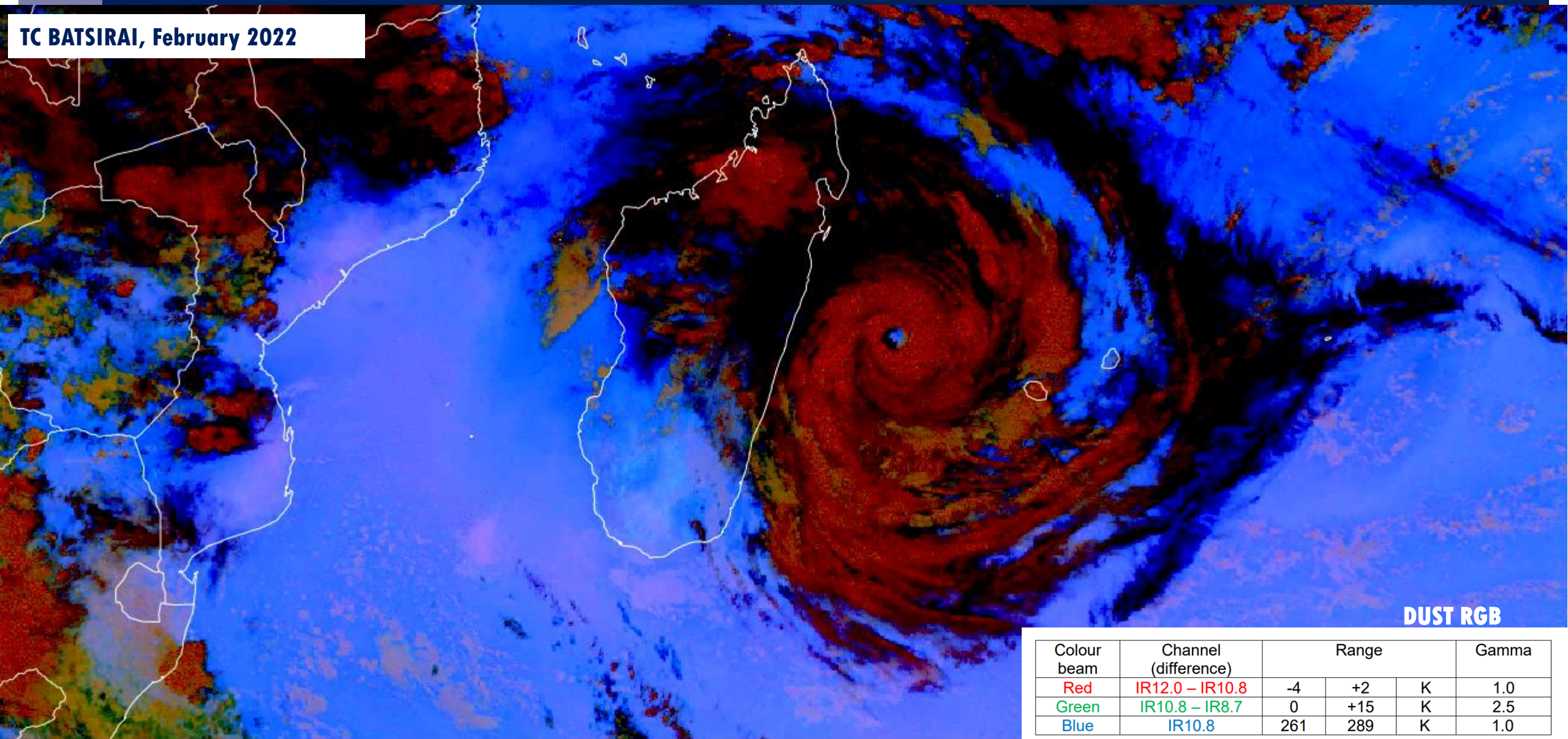
**TROPICAL AIRMASS RGB – Airmass RGB Tuned for tropical atmosphere**

	<u>Standard</u>	<u>Tropical</u>
<b>R WV6.2 – WV7.3</b>	-25 to 0 K	-25 to +5 K (6.2-10.8)
<b>G IR9.7 – IR10.8</b>	-40 to +5 K	-30 to +25 K (Gamma 0.5)
<b>B WV6.2</b>	243 to 208 K	243 to 190 K



# Following cyclone development 24 h

TC BATSIRAI, February 2022



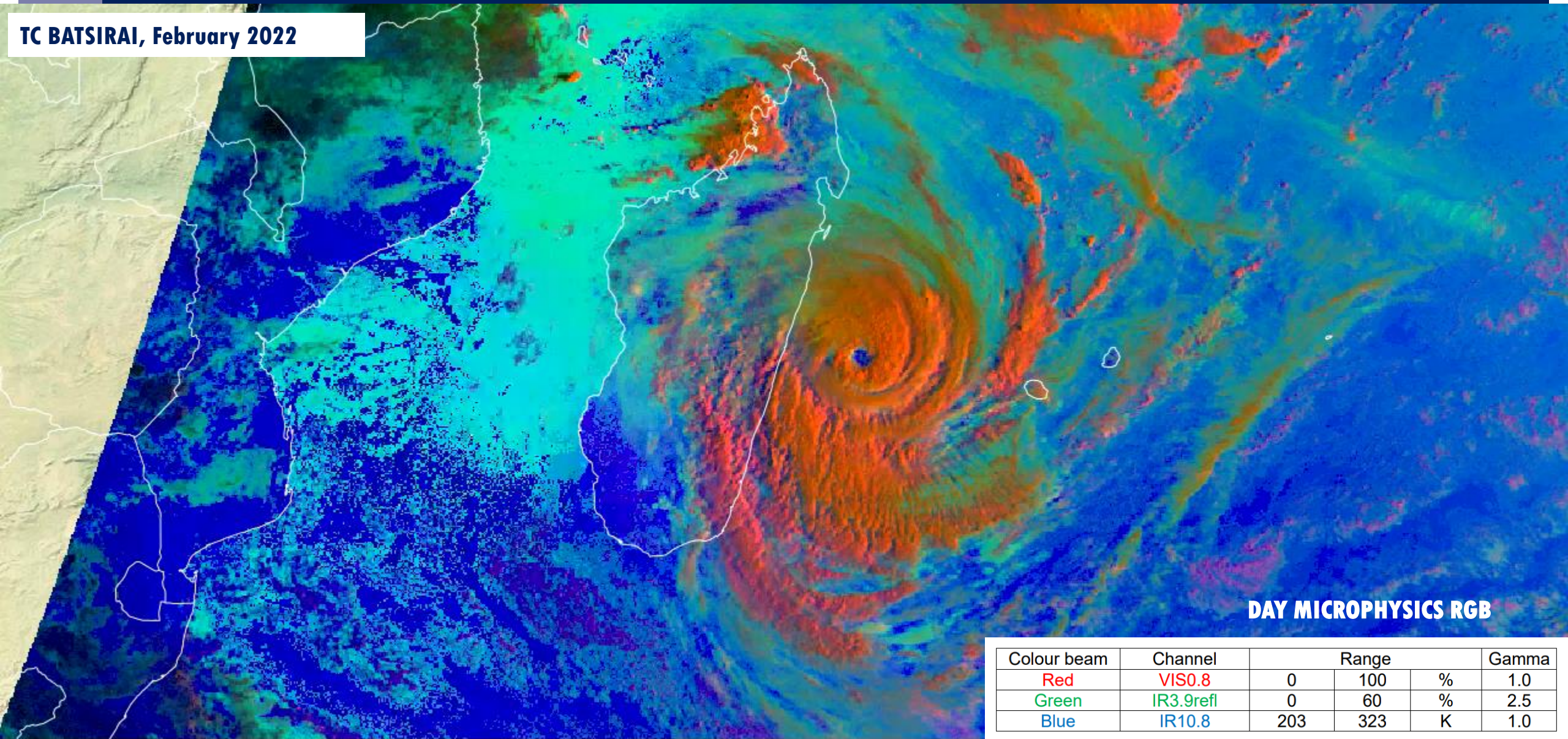
DUST RGB

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.0 – IR10.8	-4	+2	K	1.0
Green	IR10.8 – IR8.7	0	+15	K	2.5
Blue	IR10.8	261	289	K	1.0



# Following cyclone development

TC BATSIRAI, February 2022



**DAY MICROPHYSICS RGB**

Colour beam	Channel	Range			Gamma
Red	VIS0.8	0	100	%	1.0
Green	IR3.9refl	0	60	%	2.5
Blue	IR10.8	203	323	K	1.0

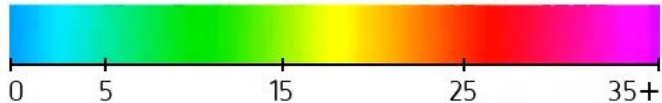


# Precipitation

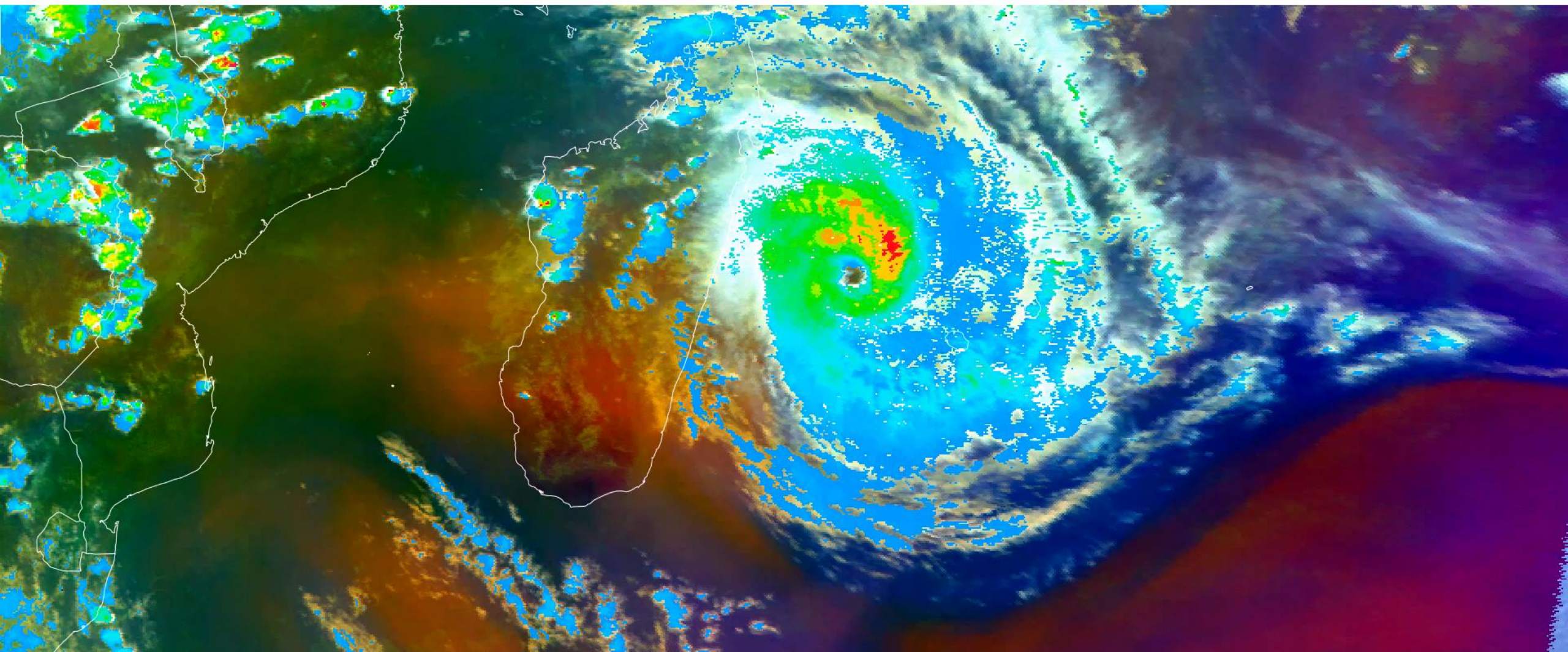
Precipitation rate at ground by GEO/IR supported by LEO/MW

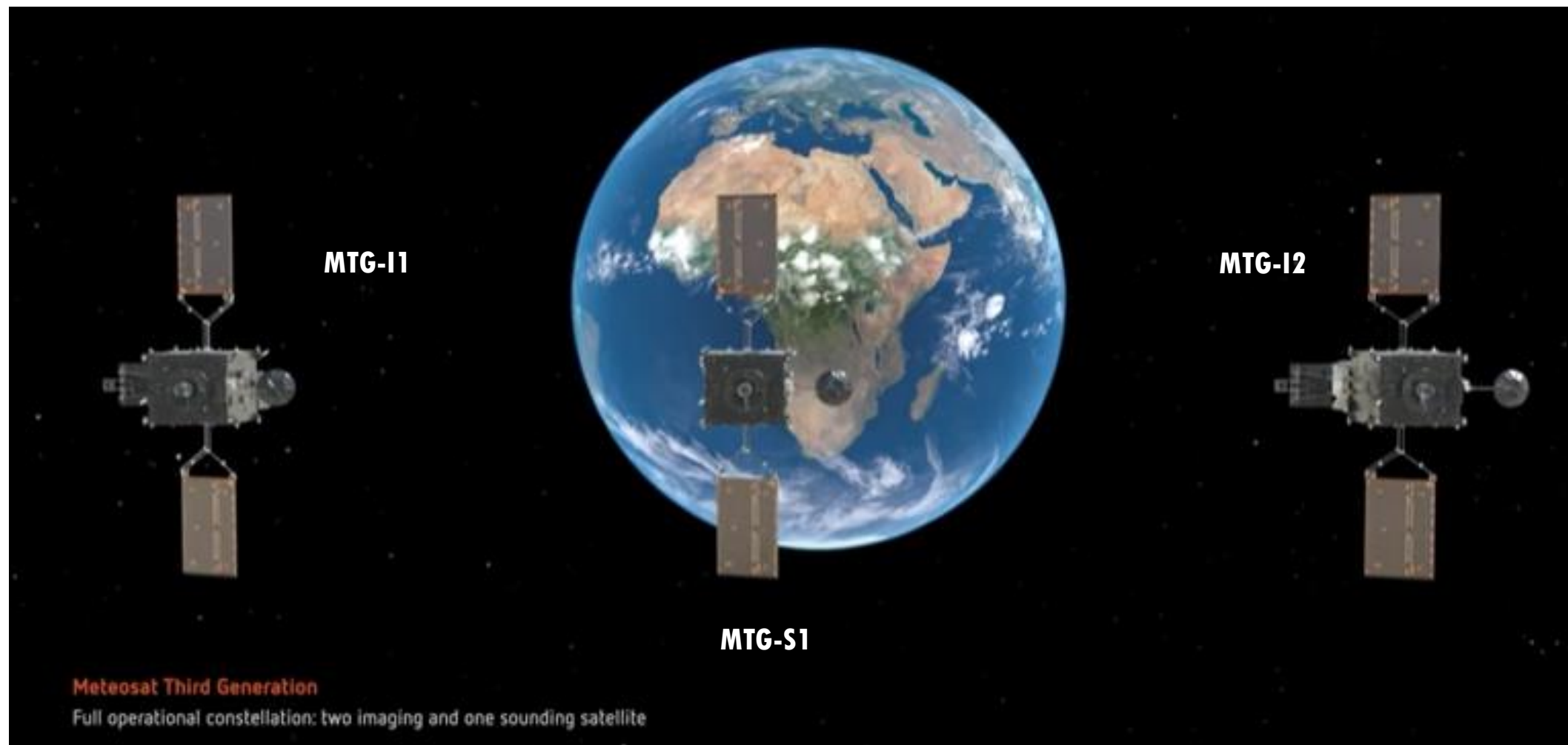
H-SAF H03B

mm / hr



**TC BATSIRAI, February 2022**

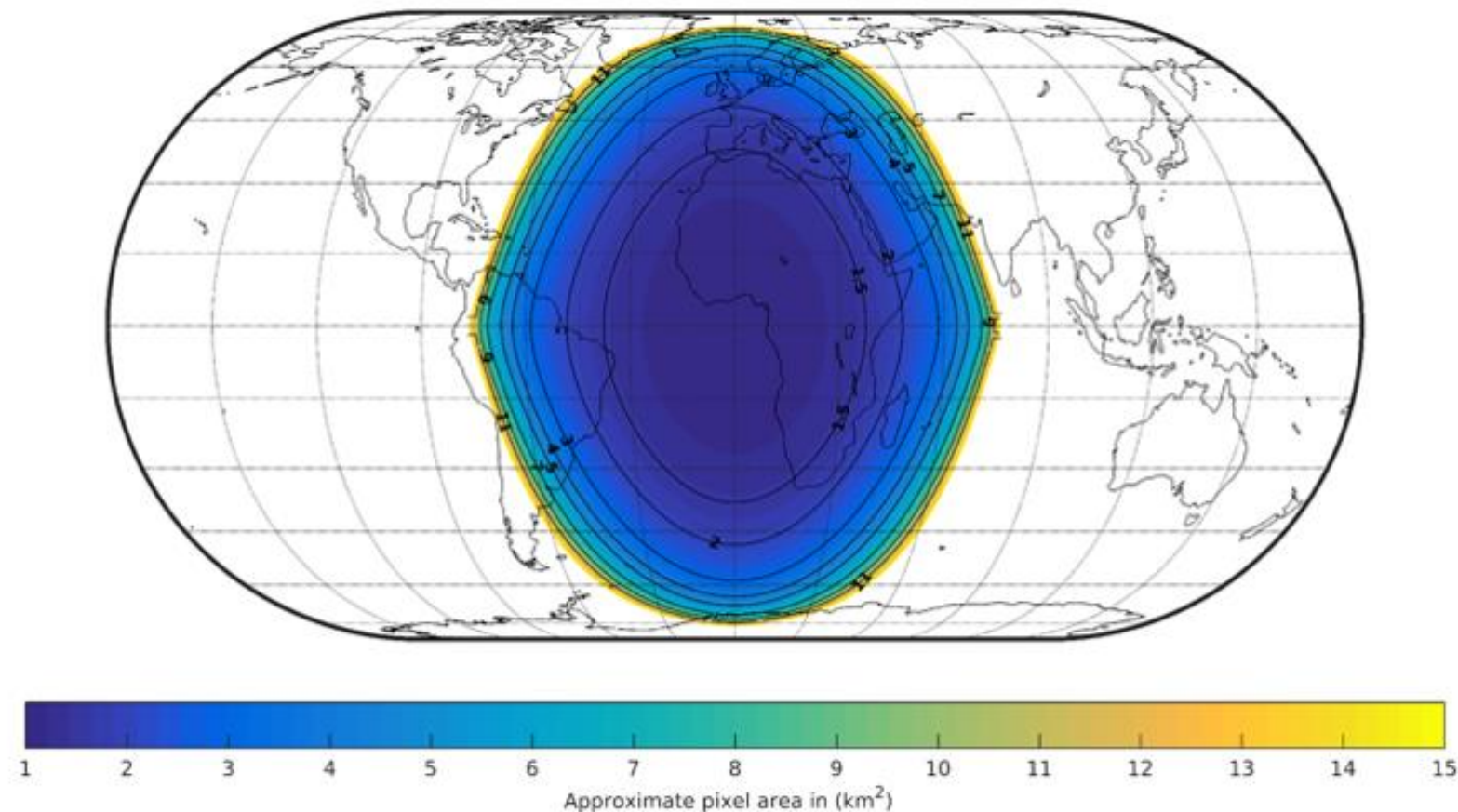




## MTG-I

### Flexible Combined Imager –FCI

- Better spatial resolution  
(0.5, 1 and 2 km)
- Better temporal resolution  
(10 and 2.5 min)
- 16 channels in the visible and infrared spectrum

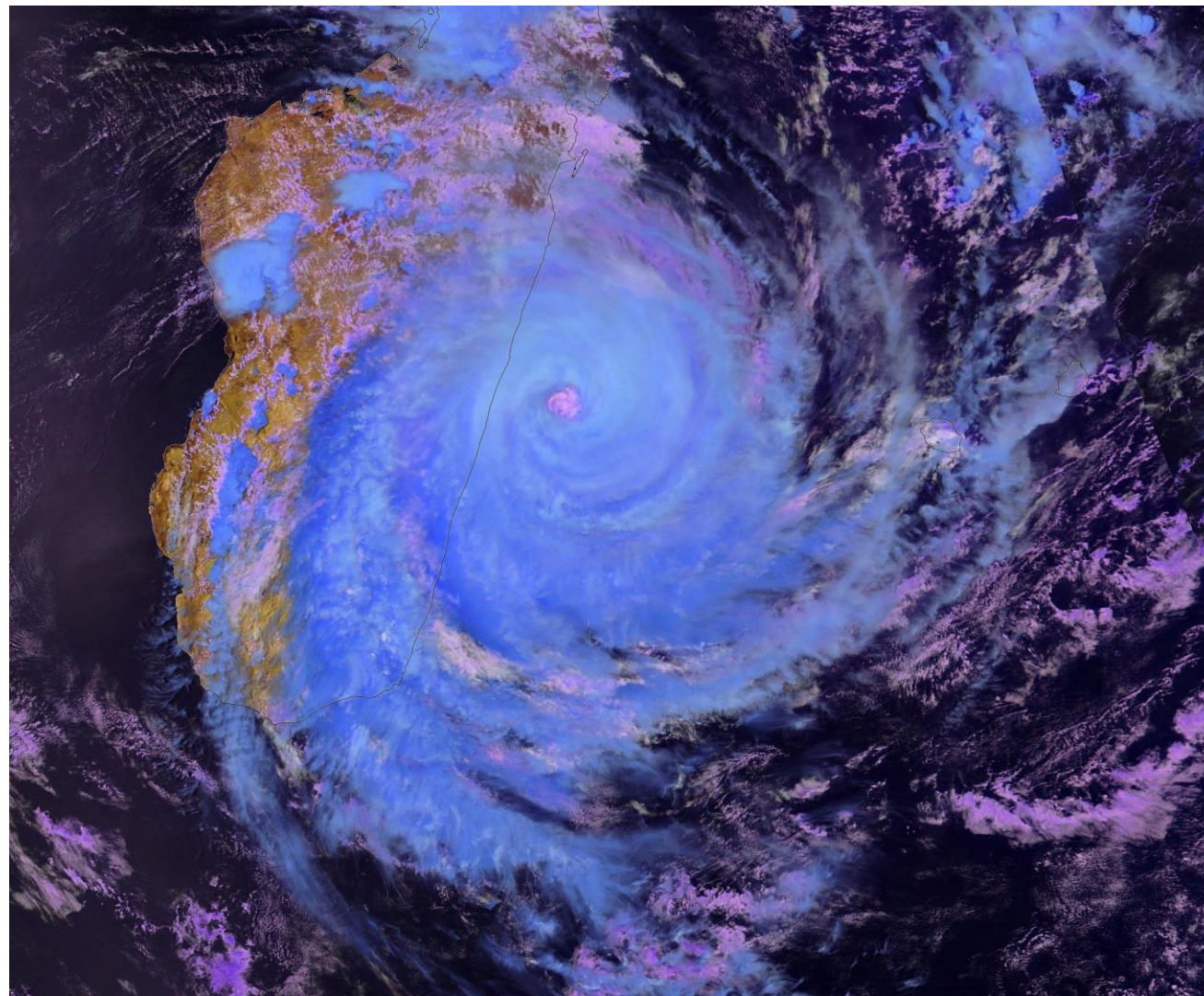


## MTG-I

### Flexible Combined Imager –FCI

#### New channels, new RGBs:

- VIS0.4, VIS0.5 > True colour RGB
- NIR2.2 > Cloud Phase RGB >>
- NIR1.3 > Cloud Type RGB,  
better thin cirrus analysis
- VIS0.9 > low level humidity



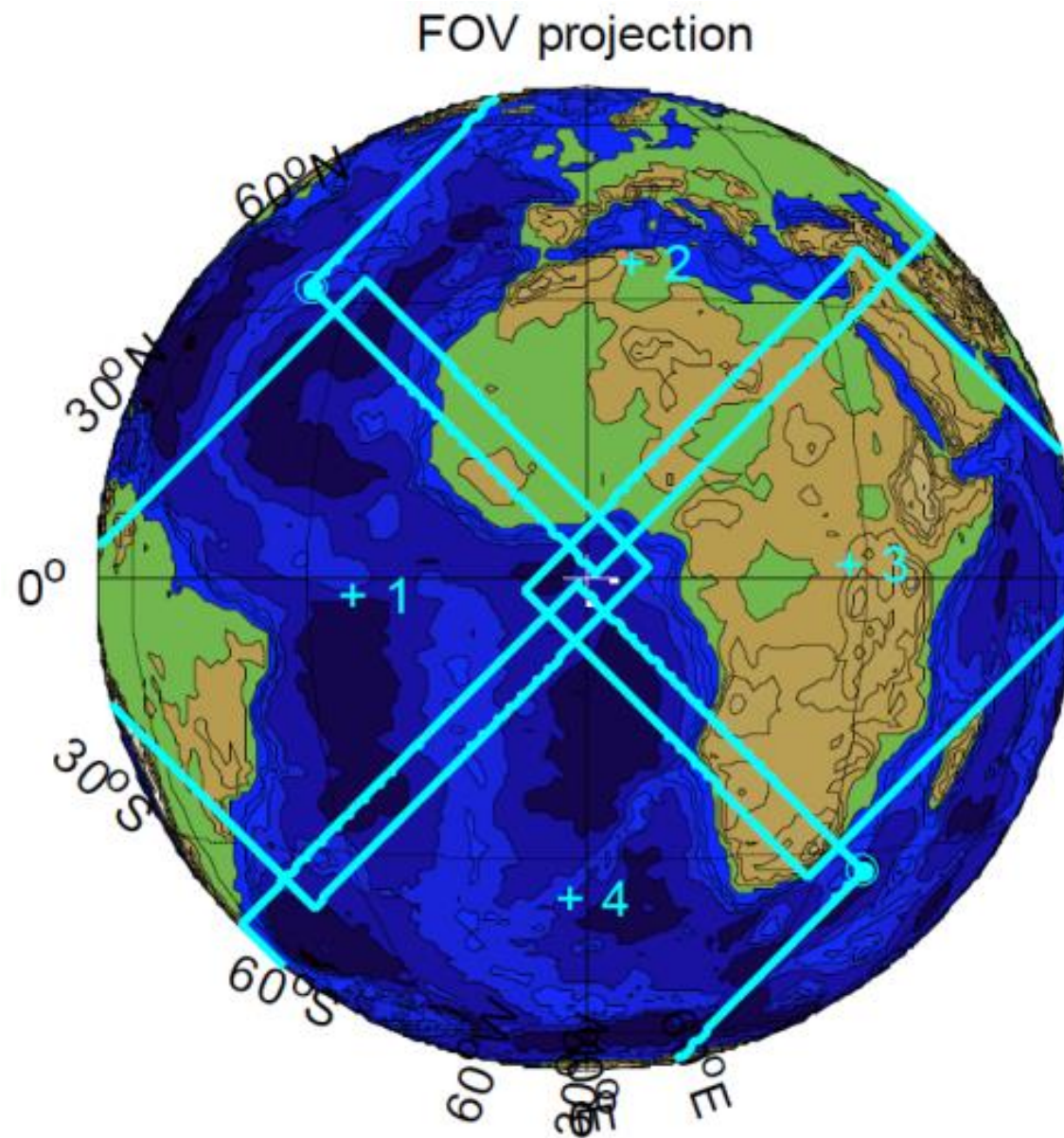
## MTG-I

### Lightning Imager – LI

- New instrument - no heritage from the MSG series
- detects all types of lightning: cloud-to-cloud, cloud-to-ground and intra-cloud flashes

>> advantage over some ground-based lightning detection networks

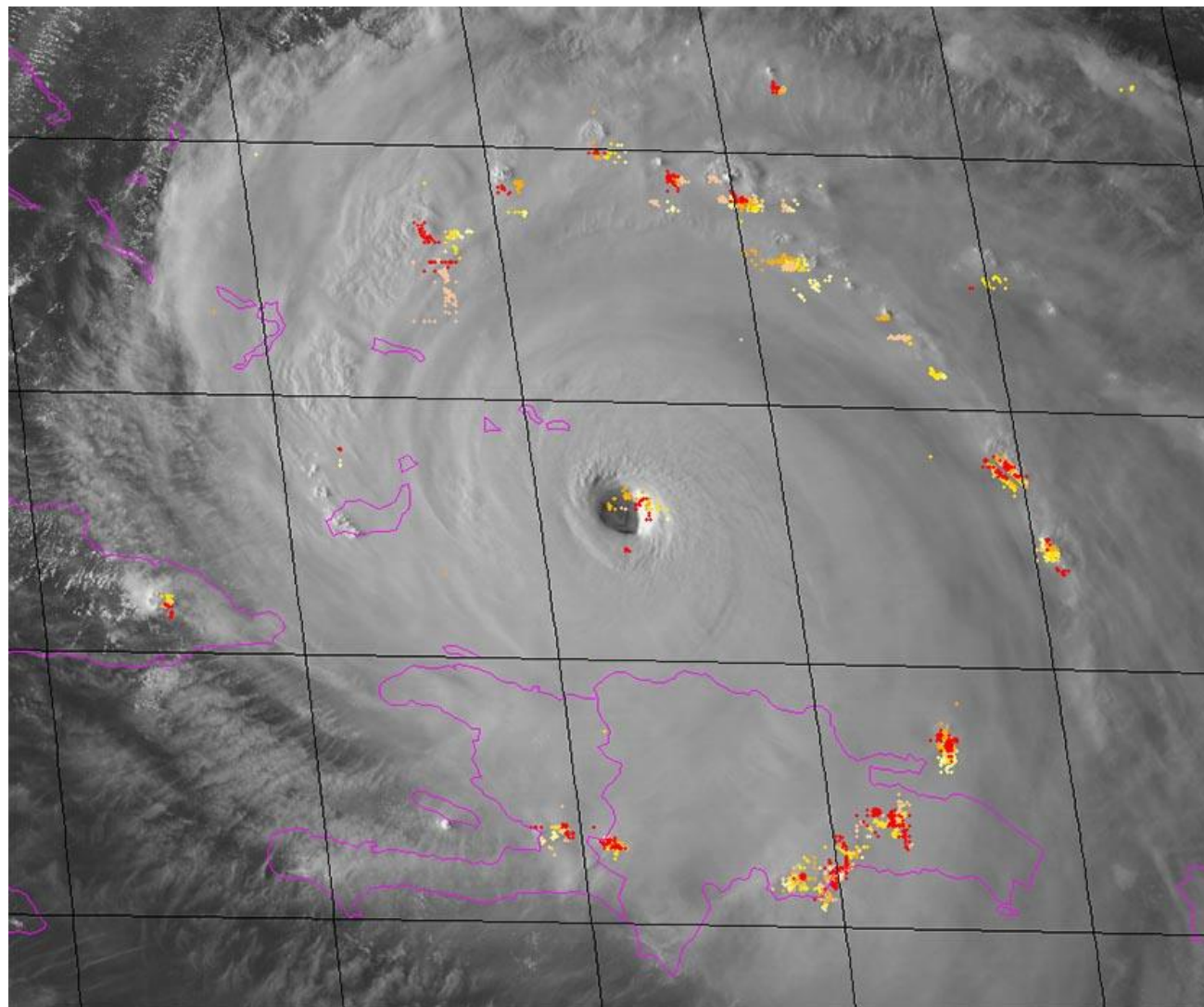
**Tropical Atlantic Ocean well covered!**



## MTG-I

### Lightning Imager – LI

- real-time data on the location and intensity of lightning flashes
- lightning activity in the tropical cyclones/hurricanes
- more precise forecasts of severe thunderstorms

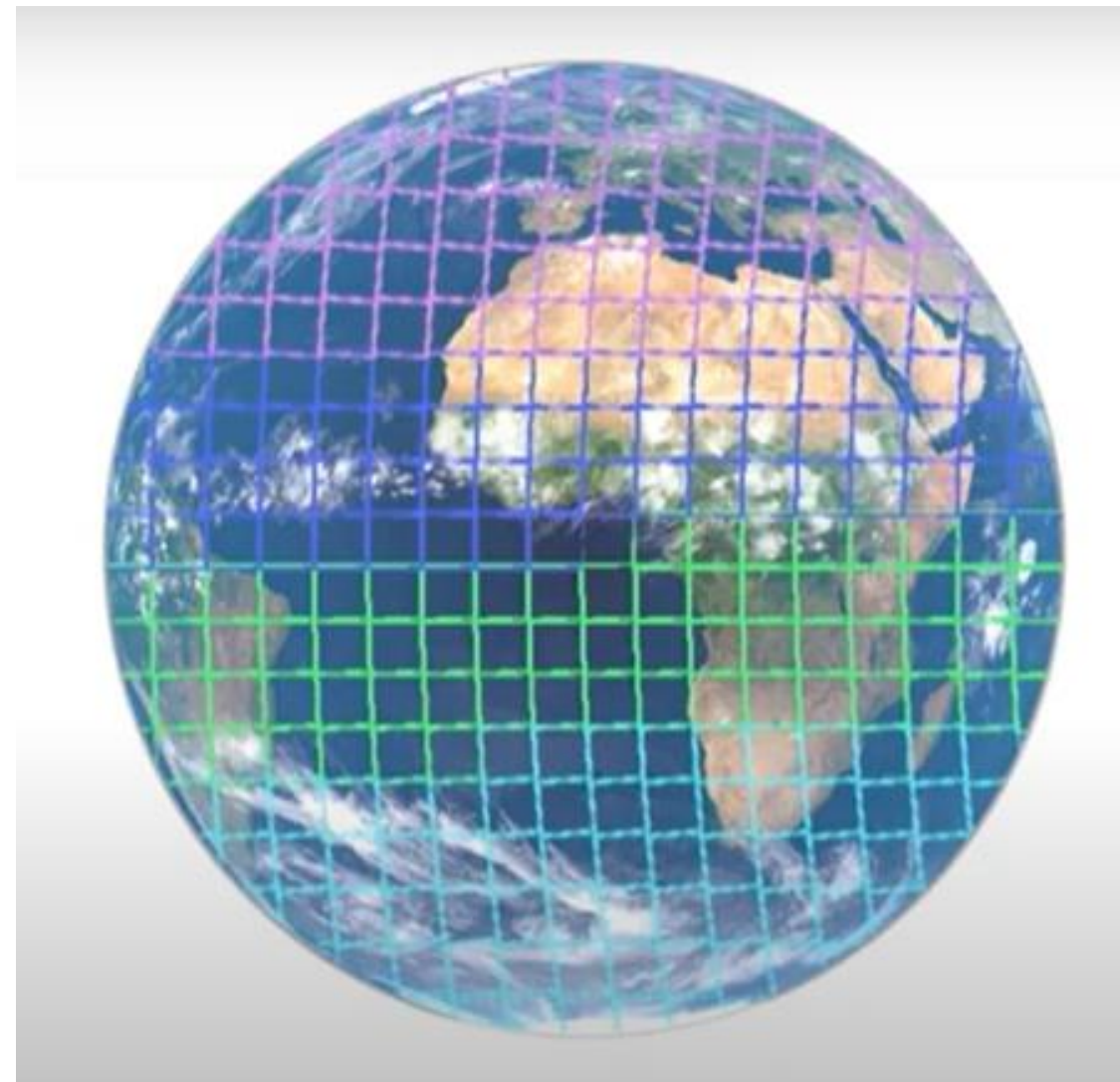


GOES-16 visible image of Hurricane Irma taken at 5:27 pm EDT September 7, 2017, with lightning strikes from the Global Lightning Mapper (GLM) instrument on GOES-16 overlaid. Image credit: U-Madison/CIMSS.

## MTG-S

### Infra-red sounder – IRS

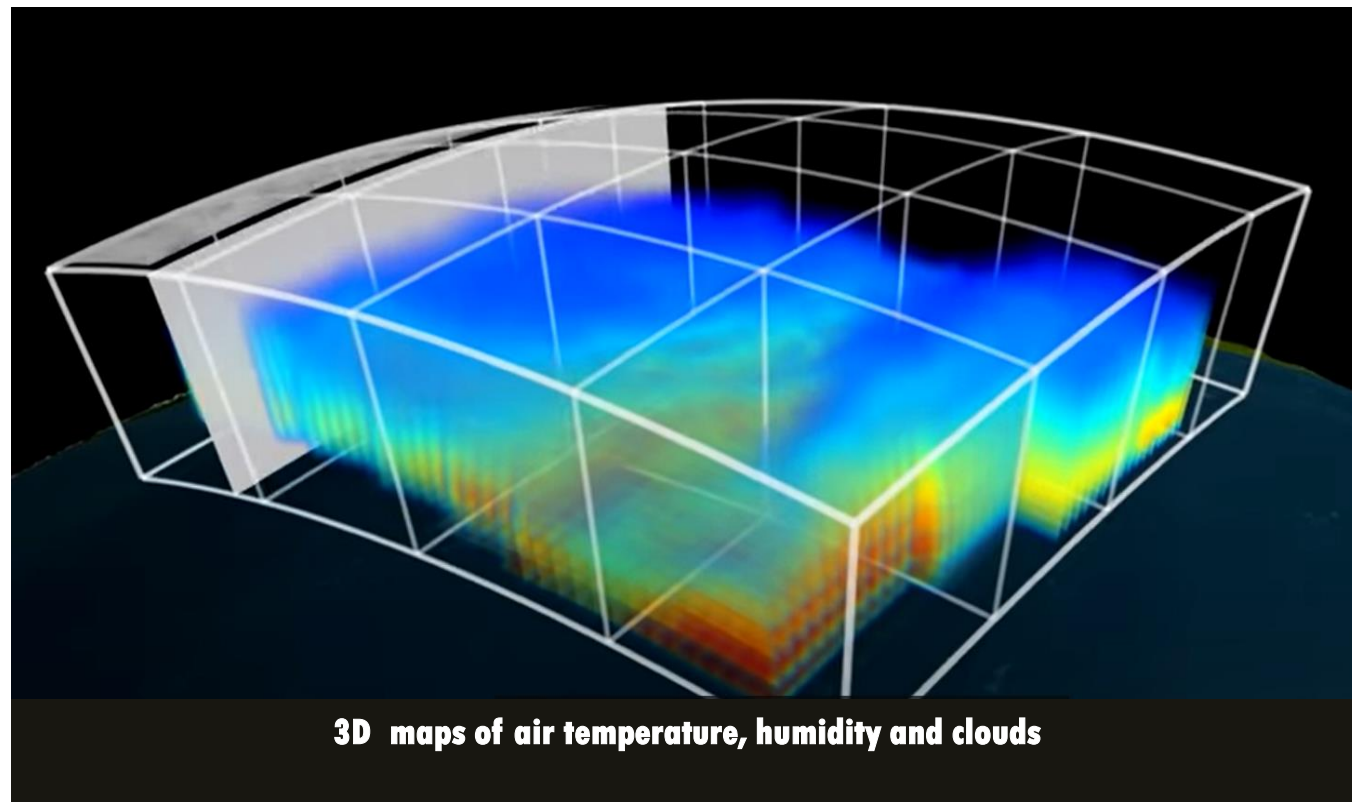
- **Two spectral bands:**  
**MWIR: 1600 to 2250cm<sup>-1</sup> (4.44–6.25µm)**  
**LWIR: 680 to 1210cm<sup>-1</sup> (8.26–14.70µm)**
- **Full disc coverage in 60 min,** **Europe**  
**region every 30 min**
- **Spatial resolution: 4km x 4km at nadir**



## MTG-S

### Infra-red sounder – IRS

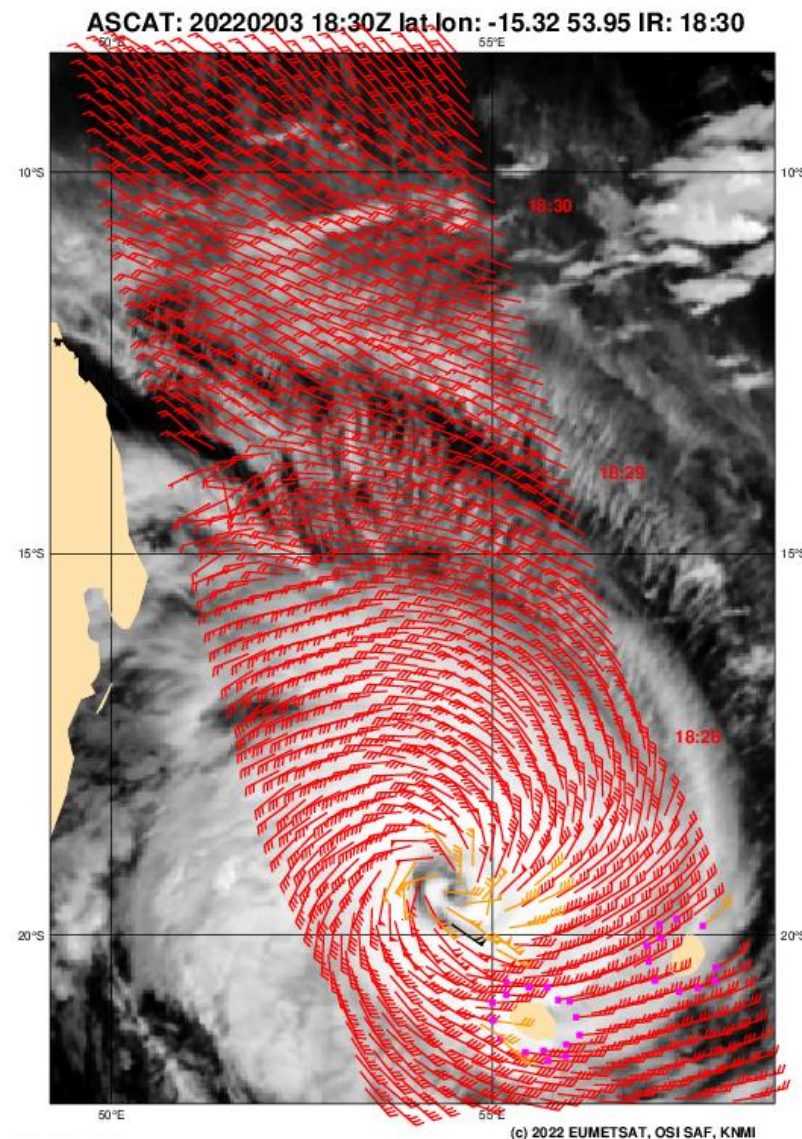
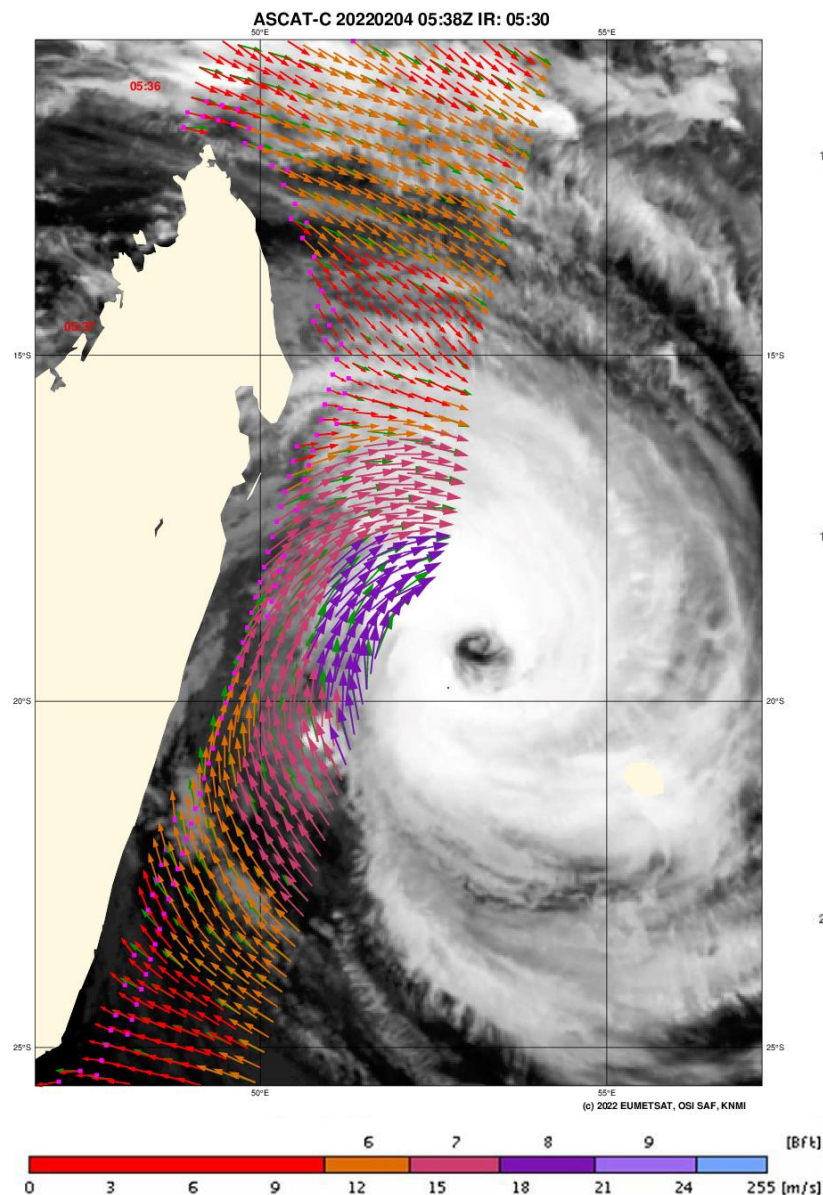
- **Sampling moisture in the tropical storm environment from GEO orbit, every hour!**
- **3D maps of air temperature, humidity and clouds**
- **Better track forecasting**



## MetOp

### ASCAT scatterometer

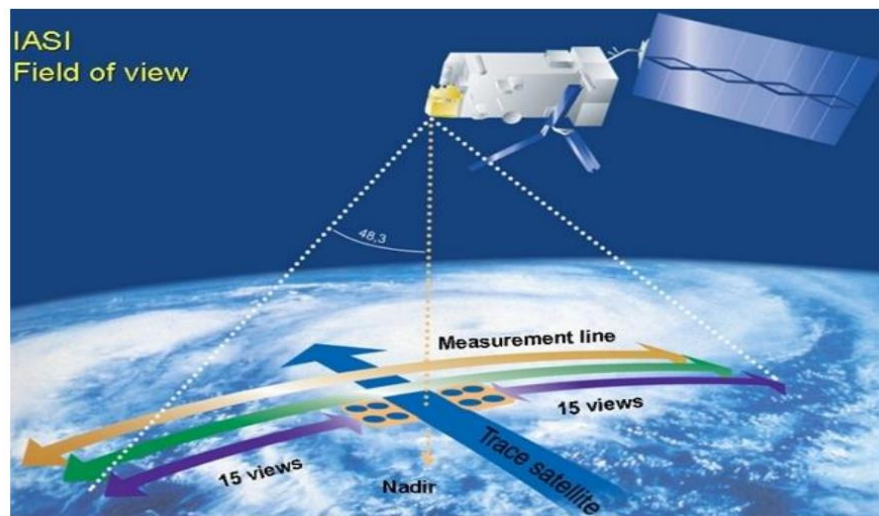
- remotely measures surface wind speed and direction over water
- detects centers of wind circulations that have the potential to develop into tropical cyclones many hours in advance of them becoming formally a tropical depression



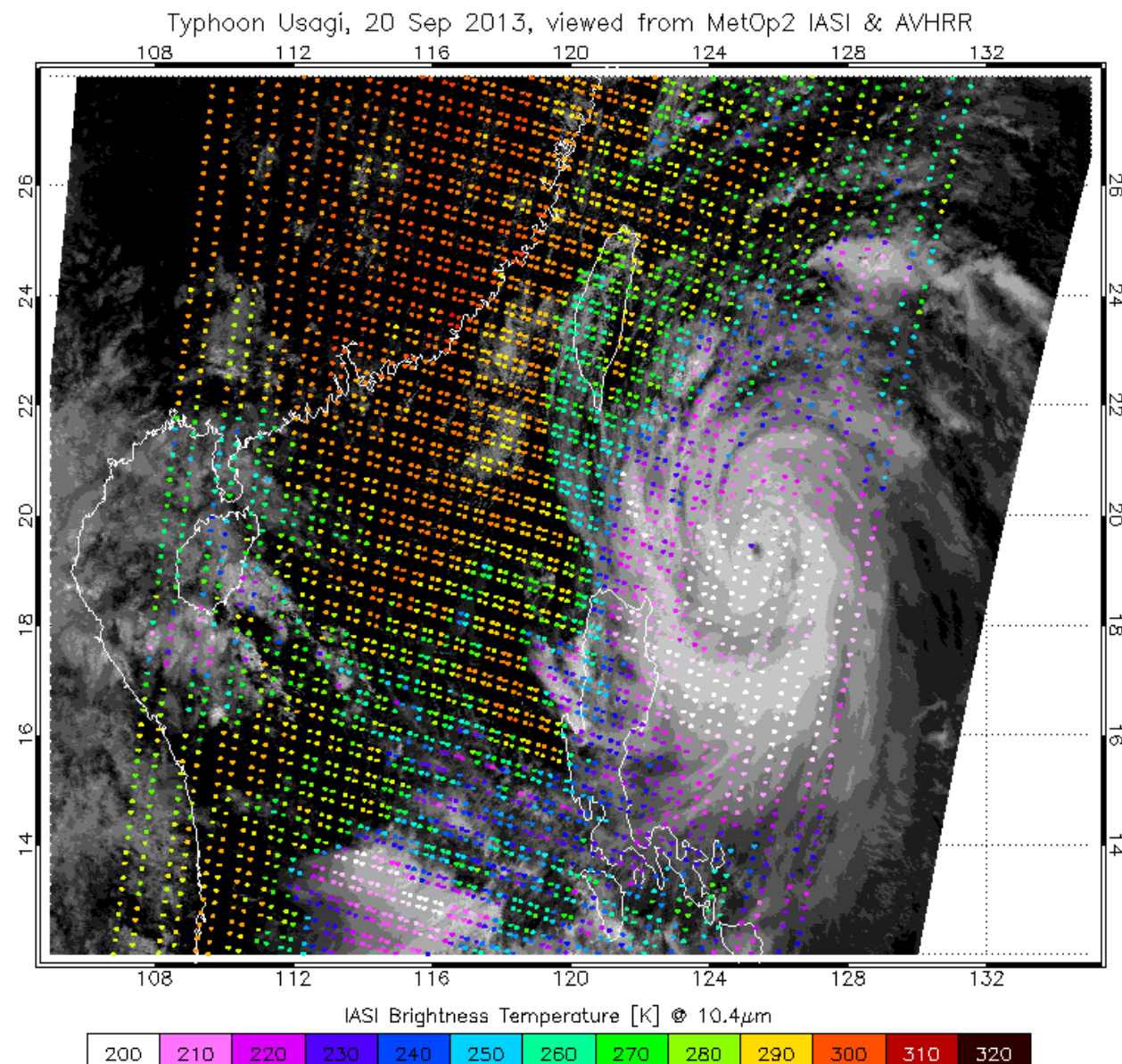
## MetOp

### IASI sounder

- temperature and humidity soundings
- Tropical cyclone forecast improved by assimilating into NWP models



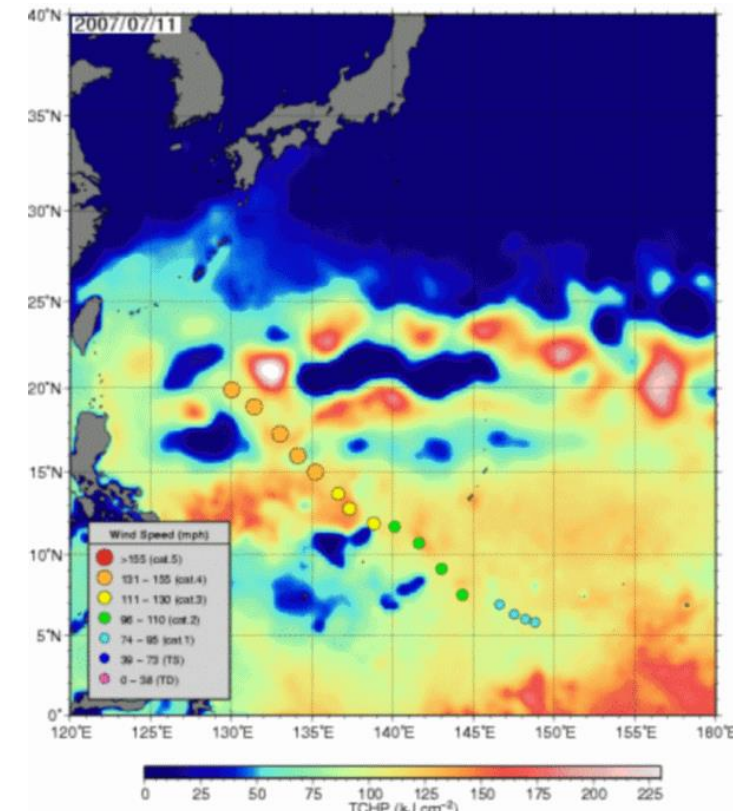
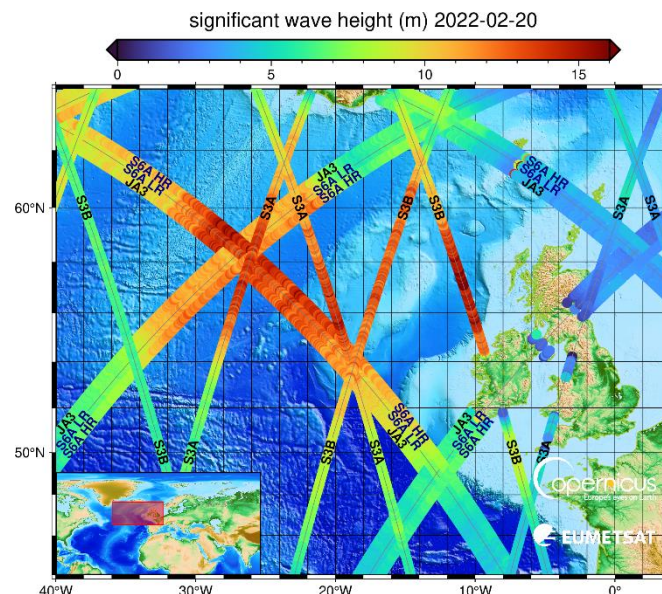
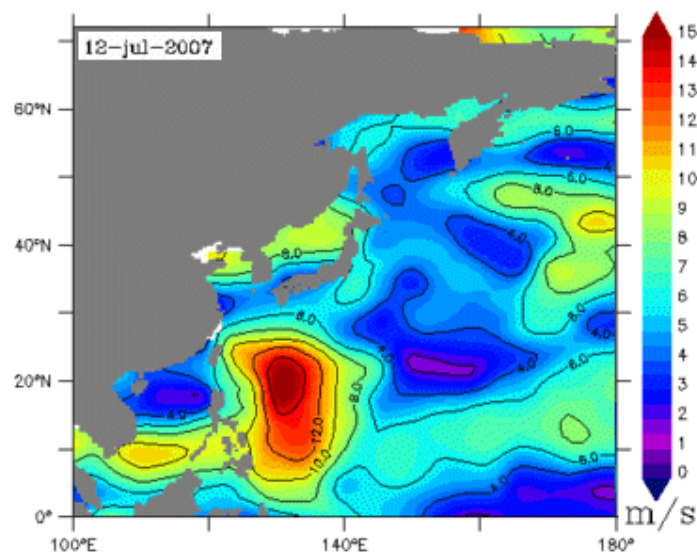
The instrument IASI on Metop, adapted from Hébert et al. 2017,



## Satellite altimetry - Jason 3, Sentinel3, Sentinel 6

### Use of altimetry for cyclone observations:

- significant wave height and wind speed measurements
- computation of the effects of the atmosphere (pressure and winds) on the sea surface height;
- monitoring intensification if the cyclone passes over a warm eddy or current
- assimilation into models, either meteorological or oceanic



### Tropical Cyclone Heat Potential (TCHP)

TCHP computed using satellite altimetry combined with sea surface temperature and hydrographic observations

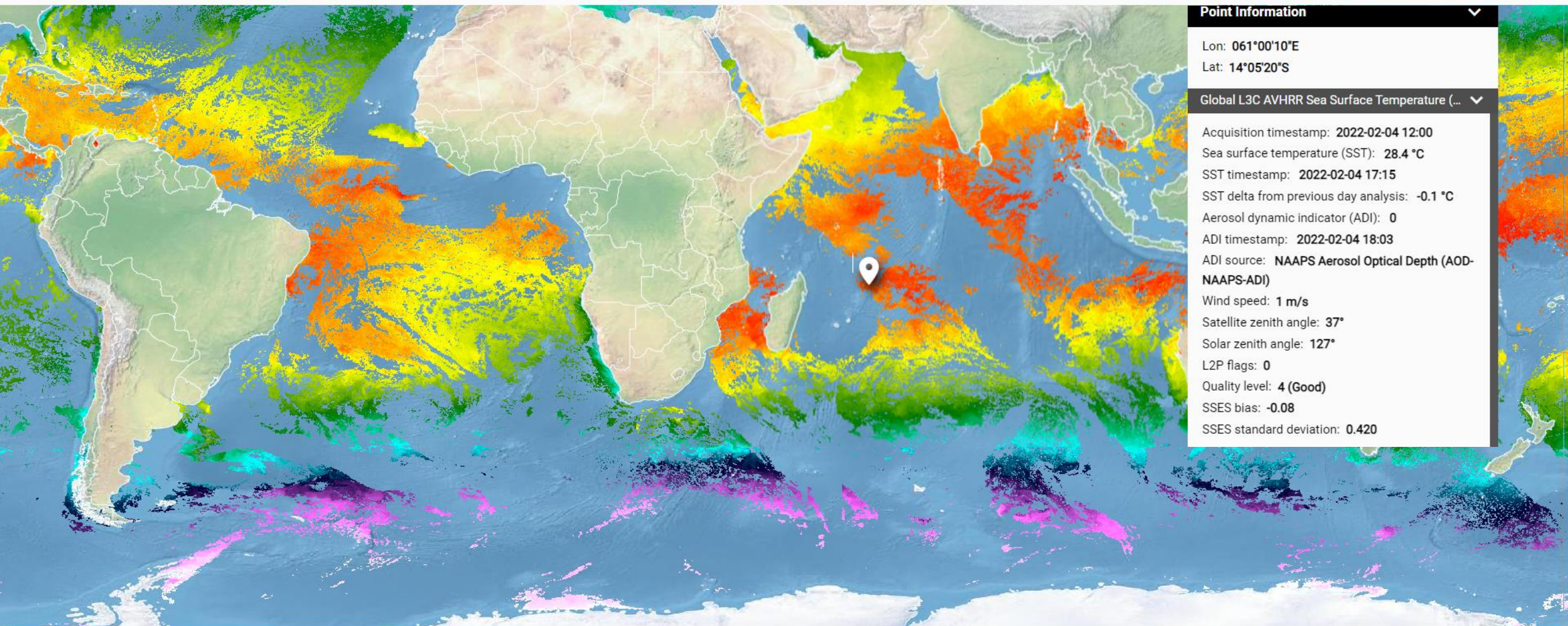
11 July 2007 - Typhoon Man-Yi appears to intensify in the region of high TCHP values.



# View from LEO – Sea surface temperature

[www.eumetsat.int](http://www.eumetsat.int)

Global L3C AVHRR Sea Surface Temperature (GHRSSST) - Metop



## Point Information

Lon: 061°00'10"E

Lat: 14°05'20"S

## Global L3C AVHRR Sea Surface Temperature (...

Acquisition timestamp: 2022-02-04 12:00

Sea surface temperature (SST): 28.4 °C

SST timestamp: 2022-02-04 17:15

SST delta from previous day analysis: -0.1 °C

Aerosol dynamic indicator (ADI): 0

ADI timestamp: 2022-02-04 18:03

ADI source: NAAPS Aerosol Optical Depth (AOD-NAAPS-ADI)

Wind speed: 1 m/s

Satellite zenith angle: 37°

Solar zenith angle: 127°

L2P flags: 0

Quality level: 4 (Good)

SSS bias: -0.08

SSS standard deviation: 0.420

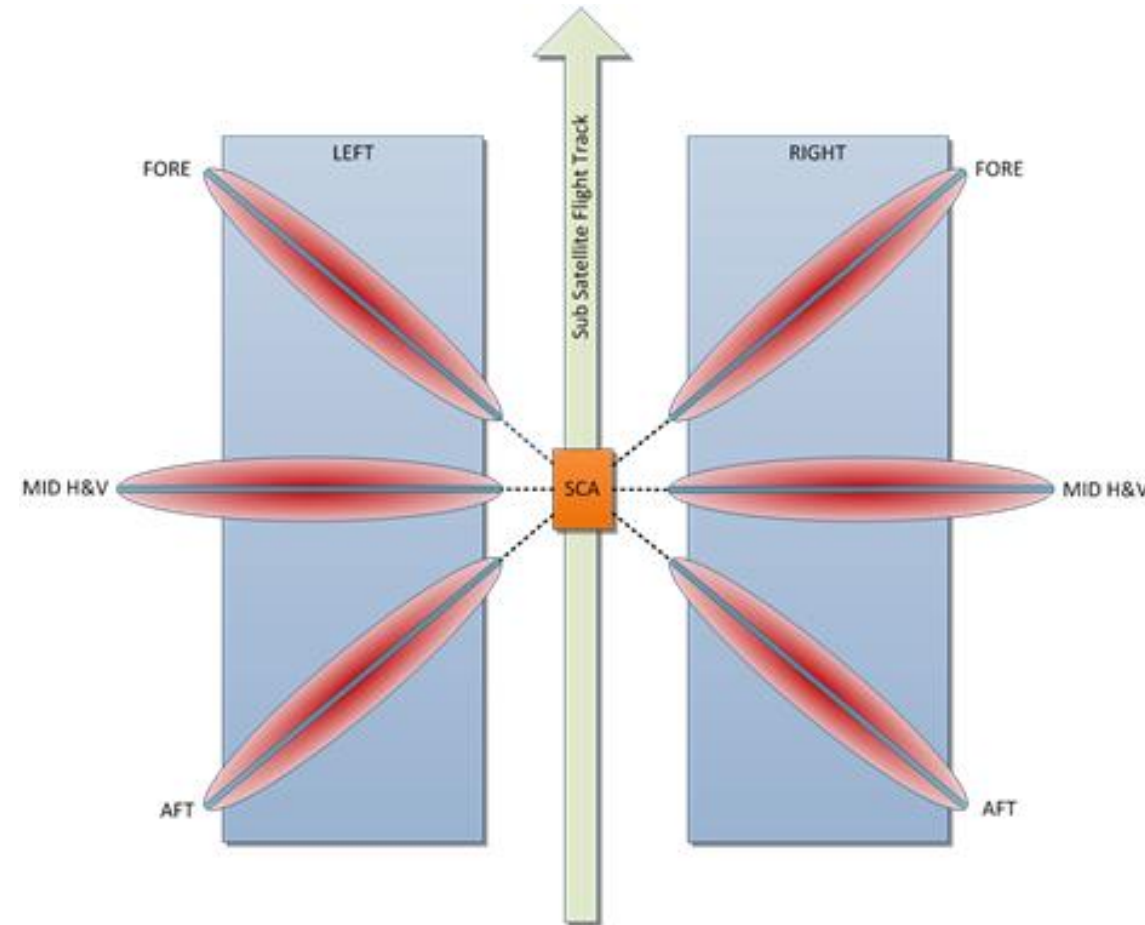
## EPS-SG

### SCA – new scatterometer

#### SCA vs. ASCAT:

- doubled horizontal resolution
- widened swath width of  $2 \times 660\text{km}$
- addition of cross-polarisation measurements
- oceanic wind vectors closer to the coast lines
- enhanced spatial coverage beyond the increased swath width

**Measurements at higher wind speeds without saturation - beneficial for observing tropical storms**

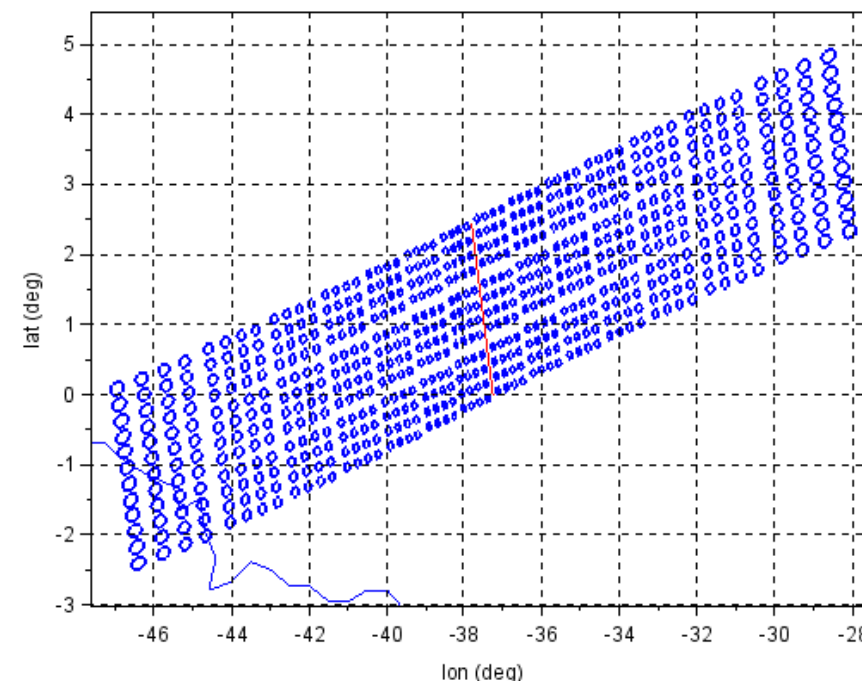


**SCA Measurement principle**

## EPS-SG

### IASI-NG – next generation sounder

- **Atmospheric temperature and water vapour profiles at high vertical resolution in clear and partly cloudy air**
- **Surface temperature over sea**
- **Cloud variables**
- **Duration of scan cycle - 15.6 s**
- **Swath width – 2000 km.**
- **>> more accurate and precise measurements for NWP and nowcasting**



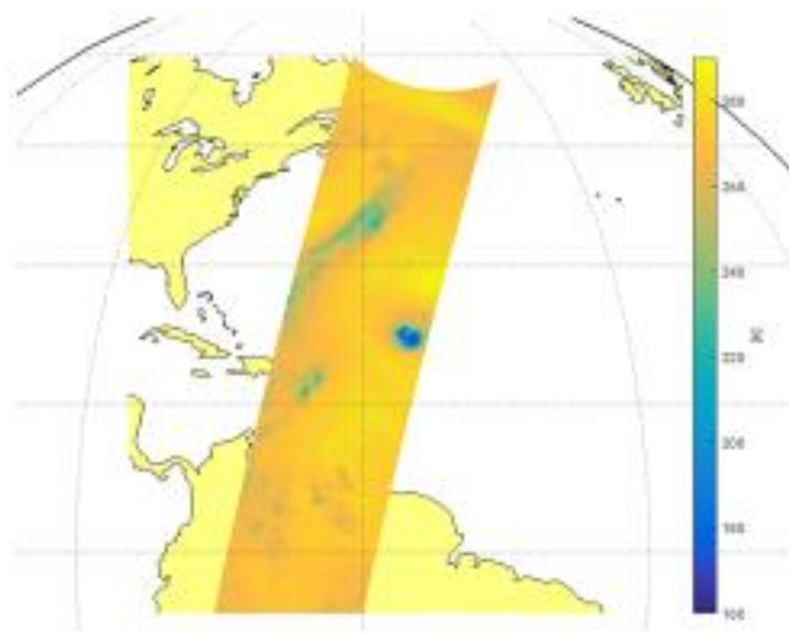
Characteristics	IASI-NG	IASI
No. of spectral samples	16921	8461
Spectral resolution	0.25cm <sup>-1</sup>	0.50cm <sup>-1</sup>
Spectral Sampling	0.125cm <sup>-1</sup>	0.25cm <sup>-1</sup>

## EPS-SG

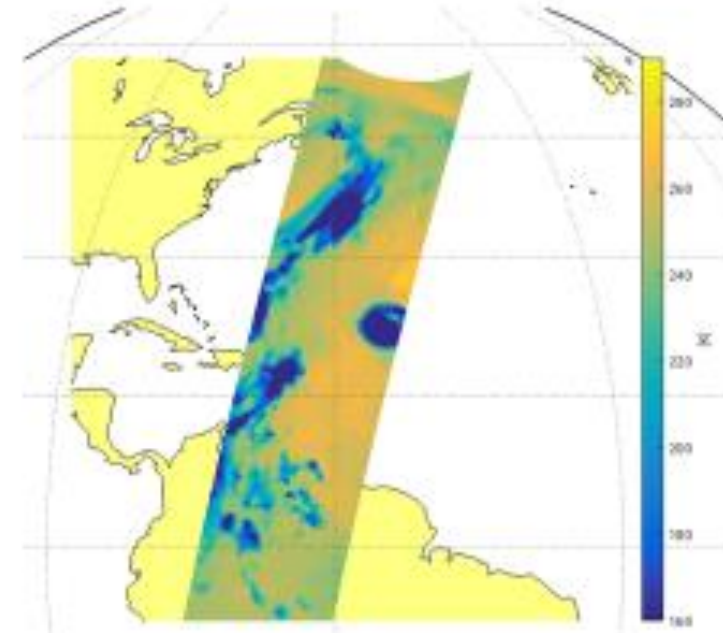
### MWI and ICI

- The ability of MW measurements to penetrate cloud helps to reveal the structure of the storm and also to locate the hurricane centre.

Simulations of hurricane "IKE" , sept 2008,  
as it would have been seen by ICI CH 01  
at 183.3 +/-7 GHz



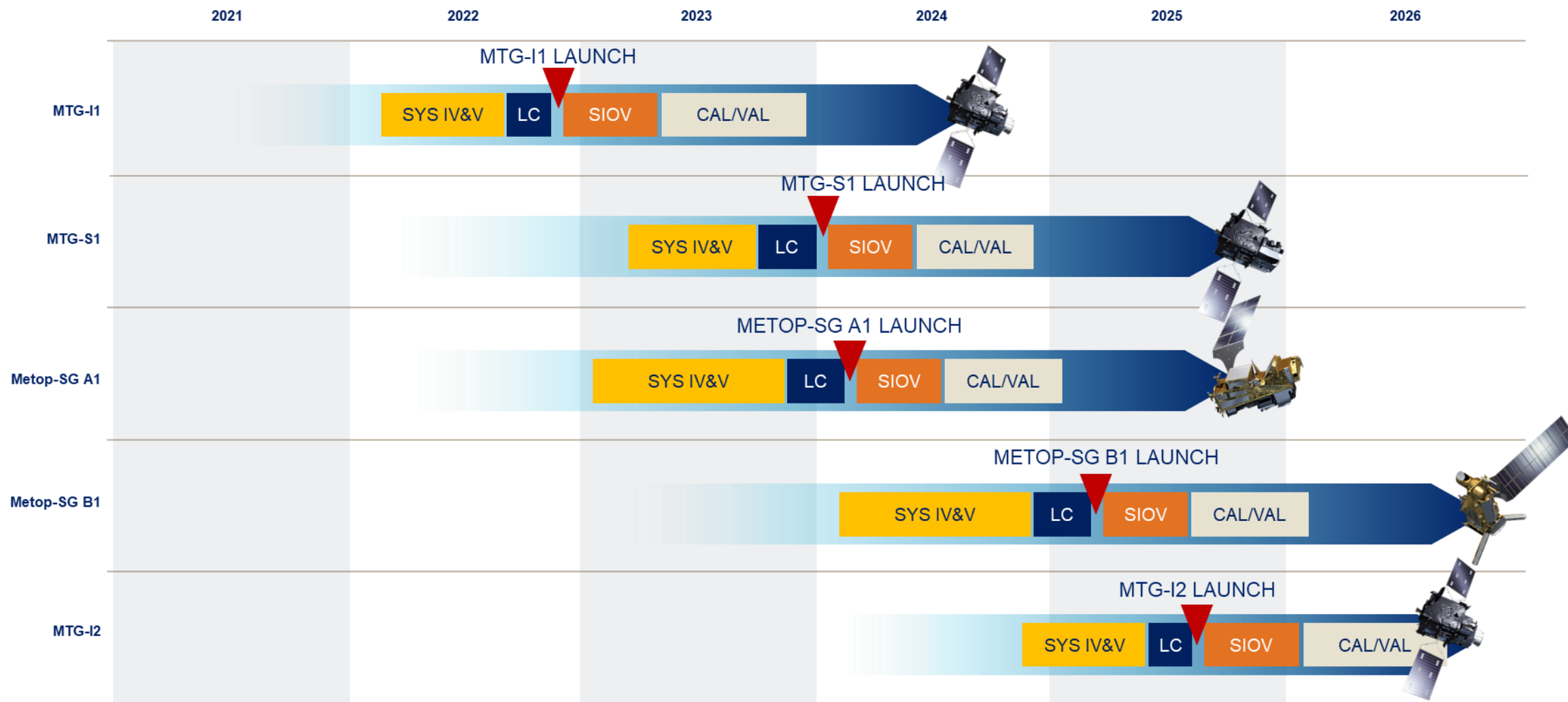
Simulations of hurricane "IKE" , sept 2008,  
as it would have been seen by ICI CH 11 at  
664 GHz





# Launching the next-generation satellites

[www.eumetsat.int](http://www.eumetsat.int)





**Thank you!**  
**Questions are welcome.**